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Copycat or Creative Innovator? Reproduction as a Pedagogical Strategy in Schools

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Abstract: This article explores how student behaviour and interactions change when teachers use ‘producing’ as a primary pedagogical strategy (Papert, 1980; Ejning-Duun and Karoff, 2014). Based on observed student and teacher actions and responses, as well as students’ production, this paper emphasizes the importance of understanding how students explore creativity and playfulness while producing in learning situations. This paper is based on a large research project called ‘Children as Learning Designers in a Digital School (2013–2015)’, funded by Denmark’s Ministry of Education, which included fieldwork in five Danish public schools, involved about 500 students, and comprised six interventions in the first, second, fifth, sixth, and tenth grades. The project’s empirical data consist of observations, participatory observation, and productions students created during the interventions. This paper presents an analysis of how students were creative and playful while producing learning material as games during three of the project’s interventions. The study is based on a specific understanding of the creativity with a point of departure (Boden, 2004; Tanggaard and Wegener, 2015) and playfulness (Karoff, 2013) that occur in learning situations. We approach creativity and playfulness as new methods of learning, through six areas of change that inform ‘[...]how today’s kids play and learn, and, more generally, how they see themselves, relate to others, dwell in place, and treat things’ (Ackermann, 2013: 119). This paper investigates how educators handle children’s productive processes in a school setting and how teachers can conceptualize and nurture play and creativity as drivers for learning. In this context, the importance of skills and acknowledgement of reproducing and re-mixing existing materials is discussed. We further argue that playfulness is necessary for creativity to occur. From this point of view, it is possible to understand how learning activities can support creativity—an essential twenty-first century skill (Levinson and Sørensen, 2015).

Keywords: (re-)production, creativity, innovation, playing, learning, games

1 Introduction

This paper addresses the question of how creativity and playfulness inform and qualify learning processes in schools. More specifically, it explores how student behaviour and interactions move towards creativity and playfulness when teachers introduce ‘production’ with digital tools as a primary pedagogical strategy (Papert, 1980; Ejning-Duun and Karoff, 2014). Based on observed student and teacher actions and responses, as well as on students’ production, the paper’s goal is to emphasize the importance of understanding how students can explore playfully and be creative while producing in learning situations and how teachers can facilitate this process.

Production as a pedagogical strategy shows good learning results. Previous research has demonstrated how children learn through production (Papert, 1980; Sørensen & Levinson, 2014; 2015). Papert focuses on how teachers can frame production as a way to work towards learning objectives by creating an environment that allows children to explore a subject. Cebeci and Tekdal (2006) have also shown how production has a positive learning potential when young people create podcasts about relevant academic subjects. Students need to be actively engaged in creating products that are personally meaningful to themselves and others. Kress (2010) points out that the abstract aspects of the curriculum become tangible through different materials. When producing, students translate abstract aspects into tangible and interactive dynamics in environments that, if carefully framed, allow students to explore the subject matter through meaningful productions. Producing is not a new idea in education. However, according to Kafai (2006: 36), producing games has untapped potential: ‘Far fewer people have sought to turn the tables: by making games for learning instead of playing games for learning’.

Our contribution to this approach is to analyse how Danish children work creatively and playfully with digital production in math, physics, physical education (PE), and Danish. The term ‘game’ is applied here in its broadest form, which includes both games bound by rules (*ludus*) and unstructured games (*paideia*). *Ludus* is a

term linked to Roger Caillois (2001), who wrote the book *Les jeux et les homes* (in English: *Man, Play, and Games*), published in 1958. He distinguishes between *paideia* and *ludus*, claiming that play exists in different forms that can be placed along a continuum on which one extreme is *paideia* (unstructured and spontaneous) and the other *ludus* (based on explicit rules). When producing games, the children can tap into an area that they are experts in, and use that knowledge to create something new (Ejsing-Duun, 2011; Karoff, Ejsing-Duun and Hanghøj, 2012).

Creativity (Boden, 2004; Tanggaard and Wegener, 2015) and playfulness (Karoff, 2013) occurred in this study's observed learning situations. By introducing six dimensions that inform how children play, learn, and create, based on Ackermann's (2013, 2014) work, we sought to investigate how students use materials and design processes to explore. As a result, this paper's main contribution is to show how students can be creative in various ways when extracting knowledge from their game experiences and information on game genres in schools. Furthermore, we seek to challenge the common understanding of creativity as something totally new created out of nothing (jf. Tanggaard and Wegener, 2015; Mason, 2003). Instead, we urge teachers to frame and embrace the potentially constructive disruptions and necessary copying that allows children to be productive and, sometimes, even creative.

The next section introduces the research context. Section three presents the theoretical points of departure. Section four analyses three learning situations that arose during our empirical research. Section five discusses the concepts of creativity and playfulness in the context of learning.

2 Research context

This paper is based on a large research project called 'Children as Learning Designers in a Digital School (2013–2015)', funded by Denmark's Ministry of Education. This empirical research consists of fieldwork in five Danish public schools, involving about 500 students and 30 teachers, and it included six interventions in the first, second, fifth, sixth, and tenth grades. The schools were chosen from a pool of candidates to guarantee geographical and socioeconomic dispersion (Levinson et al., 2014). The project explores the area of students' production and involvement, and, more specifically: 1) how students' digital production affects learning processes and the quality of learning results regarding subjects and trans-disciplines and 2) how information and communications technologies that allow students to act as designers of their own learning practice in terms of form, framing, and content affect their learning, engagement, and motivation.

Due to the project's complex nature, a mixed methods approach was used. In their research, Johnson and Onwuegbuzie (2004) sought to overcome incompatible findings within a complex field. This, in turn, has led us to follow a strategy linking fieldwork inspired by ethnography and design-based research that emphasizes experiments and collaboration with practitioners (for a further elaboration of this methodology in Levinson et al., 2014, see also Magnussen and Sørensen, 2010, and Cobb et al., 2003). As Johnson and Onwuegbuzie (2004: 16) suggest, the '[b]ottom line is that research approaches should be mixed in ways that offer the best opportunities for answering important research questions'. The present study's empirical data consist of observations, participatory observation, and productions created by students during the research project. In this paper, we focus on three significant situations to illustrate a tendency in our observations, which are presented in the following three subsections.

2.1 "Are you fooling around?"

This example is taken from a mathematics intervention with children in the first grade (approximately eight years old). The children were introduced to the computerprogram Geogebra. The assignment was to create a shape using this mathematical tool. Afterward, the game called for the children to exchange shapes with their classmates and imitate another shape.

Oliver is a boy who often goes his own way. At the beginning of the intervention, he refused to use Geogebra and, instead, drew his shapes in Paint (a Microsoft program). During the second week, he used both programs, still preferring Paint and often running both programs at the same time. However, he did draw a mouse in Geogebra, using shapes of circles in different sizes. The teacher told him to use Geogebra for his assignment, and, thereafter, he closed Paint or immediately switched to Geogebra whenever the teacher came near. In the end, as other students evaluated their assignment, he changed his mouse picture, drawing on top of what he had already made, and, instead of evaluating it, redesigned the figure. Contrary to his classmates, who all did

almost the same green star with blue corners, Oliver apparently needed to continuously play around with the shapes and the tool's possibilities. The only way to do that was to avoid attracting the teacher's attention and do something different than the others.

2.2 “Did you make this yourself?”

This example is taken from a mathematics intervention in which children in the fifth grade (approximately 11 years old) were instructed to program games using iPads and the software application (app) Hopscotch. The children were extremely engaged in creating good games, and they worked intensely on their products. They asked for extra lessons on mathematical subjects relevant to their games, including complex areas such as algebra and exponential growth. They also assessed each other's products throughout the project (the example is also discussed in: Misfeldt and Ejning-Duun, 2015).

Simon is a student for whom math is hard. From the beginning, he failed to complete the tutorial—a sequence of tasks designed by the teacher that introduced students to programming with Hopscotch. However, he was highly engaged in the process of making a game. In the morning on the project's third day, he found the teacher before class had started to show her his progress. She looked at the game that he had made and asked him whether he had made it himself. He replied that he indeed had developed it himself. She inquired about several features of the game, and he had difficulty explaining how they had been made. He continued to work on the game throughout the next period. As he uploaded his finished game, an icon indicated that he had retrieved a coded game from the Hopscotch community and remixed it.

In the end, as other students presented their games, Simon followed their information with interest and then presented his own game. After he had received feedback on the game, he continued tweaking it in terms of speed, points awarded, and so on. Once the project was finished, the teacher emphasized Simon's motivation as a particular success and benefit. He was captivated by the process, and he kept working with the subject matter, without even asking for much help. She pointed out that he has academic difficulties and, normally, has a hard time following lessons and presenting anything to the class. Without doubt, Simon felt ownership—and was proud—of his game. We cannot conclude whether his learning outcome was significant, as this was not assessed, but Simon did learn that math could be interesting for him and a meaningful way for producing games.

2.3 “I would like to change it a bit, because it needs to work”

This example is taken from a trans-disciplinary intervention between PE and Danish with children in the first grade (approximately eight years old). The children were introduced to seven different traditional games in PE, primarily hiding and catching games, both working in teams and working individually. The assignment was to create a new game and a multimodal instruction text of how to play the game. The game was supposed to be played by other students using the instructions.

Nadja, Maya and Adam were working as a team on a game that combined elements from hiding games with elements from catching games, both of which they had tried during PE. The reassembled existing knowledge came both from PE and from the children's wide repertoire of different games that they spend time on outside school. They designed a game where all but one of the participants have to hide while the finder/catcher counts down, then the finder/catcher must find each participant and catch them—if they fail to catch someone, that person can hide again.

The teacher encouraged the children to play their game several times to make sure it worked well. The teacher also tried each game, and offered constructive feedback that led to the students revising their games and instructions. As a final, all the children tried out the different games. The team that came up with the game would remain inside while the children trying the game were outside. The designers could watch how other teams played their game—and thus see how well they understood the instructions—using FaceTime. With no way of talking to the students trying the game out, the designers were only an audience for the game they invented. They experienced how their game worked for others, and they wanted to change parts that did not work out as they thought it would. The teacher encouraged them to change any parts that did not work. By following the iterative process of creating the game—trying it out, re-creating the game, having others try it out, and lastly re-creating the game again after seeing any errors and possibilities for improvement—the teacher and the students shared a meaningful and educational experience.

3 Creativity

To many researchers, creativity is still first and foremost associated with what is new and meaningful. Mason (2003: 7) states: 'To create is to act in the world, or on the world in a new and significant way'. In that perspective, repeating or copying something is not considered creative just as routine activities, such as practicing in order to master a specific task, are not creative. However, recent research has a critical perspective regarding this 'obsession with novelty in public organisations and public rhetoric' (Tanggaard and Wegener, 2015: 14). That is the case for Boden (2004), Ackermann (2013) and Tanggaard and Wegener (2015). To them, nothing comes out of nothing, and combining or re-mixing existing materials with new situations is considered an important aspect of creativity. Tanggaard and Wegener (2015: 1) specifically argue against the '[...]excessive enthusiasm towards the novelty aspects of creativity and innovation, which overshadow the potential of old ideas and past experience as drivers of change'.

Boden (2004) is preoccupied with understanding the phenomenon of human creativity and how computers can help us understand it, as well as using the understanding of creativity to model computers. Understanding creativity from this perspective is relevant as digital media is used as a driver for production in all of the three examples. Tanggaard and Wegener (2015) are interested in re-creation and re-creativity as part of innovation and how to translate this perspective into a pedagogy that teaches people to work in a creative fashion, which is relevant to the focus of this article as we want to suggest how teachers can nurture creativity in school. Ackermann (2013, 2014) addresses the way children play and learn through interactions with others and with things, which is included here as we also want to understand how children approach creativity and production.

3.1 Nurturing Creativity

Tanggaard and Wegener (2015) underline the importance of focusing on imitation and already existing knowledge when creating the best possibilities for creativity to happen. Their paper highlights creativity as a result of a reinvention or resampling of existing material and acknowledges already existing practices and ideas as an important point of departure. Tanggaard and Wegener (2015: 15) argue: '[...]if innovation is in reality build on re-creation as suggested in this paper, schools could become a kind of museum innovation hubs—simultaneous a place for the old and the new and its fusion'. In order to support students' creativity, they need to experience '[...]educational structures and practices that encourage access to existing and "old" knowledge seen as potential bricks for future re-creation, while also allowing for a greater personalisation and autonomy of learning' (Tanggaard and Wegener, 2015: 14). This means that students are not taught a set curriculum which represents the world as it is but are instead allowed to form new ideas about the world. This is nurtured through possibility thinking that challenges students and teachers to pose 'what if?' questions. These questions '[...]can only be formulated and answered by adopting new positions towards the problem at hand, by noticing not only how things "are" but how they "can" or "should be"' (Tanggaard and Wegener, 2015: 14). To encourage creativity in schools, it is necessary to give learners the time they need to 'dig deep' into a subject through research, experimentation, and revision (Brinkmann and Tanggaard, 2009). Teachers must emphasize not only the product, but the process as well. The production process must happen along with '[...]perception and reflection by looking for models to emulate, and finding links between those models and one's own work' (Brinkmann and Tanggaard, 2009: 252). Throughout this process, feedback from peers and teachers is essential for learners to reflect upon their findings.

Boden (2004: 28) agrees that ideas grow out of what is: 'Insights do not come from gods—and they do not come from nowhere, either. Flashes of insight need prior thought-processes to explain them'. In other words, what is new builds upon what lies before. In order to nurture creativity the teacher needs to be able to recognize it. Boden has described creativity as having three forms. These three forms relate to the subject matter—in Boden's words, the 'conceptual space'—in three different ways.

The first form is *combinatorial* creativity, which exploits shared conceptual structures to create analogies or metaphors. As an example, Boden mentions how a journalist might compare a politician with an animal, creating a conceptual pathway between the two. The process, thus, is guided by associative forms. Similarly, Tanggaard and Wegener (2015) point out that scanning a different (foreign) domain than the conceptual space one is working with for old and well-established ideas and combining these ideas with the new domains and practices, i.e., the conceptual space, is a great opportunity for creating something new. In game production,

game knowledge is used as a metaphor to highlight dynamics in the conceptual space, but also knowledge about previous game designs and experiences is applied.

The second form, *explorative* creativity, relies on culturally accepted styles of thinking (i.e., artistic genres). This conceptual space is restrained by a set of generative rules and is employed when being creative in an explorative manner. When producing games, players need to explore the rules' structure throughout the game production in order for the game to be playable. According to Tanggaard and Wegener (2015: 2), '[...]much inspiration to innovate among practitioners involving creative actions can come from what is "old" and that a practical as well as a theoretical shift to re-creation is timely and relevant'. This implies exploring the existing thinking used to address the domain that is being innovated and perhaps framing it differently.

The last kind of creativity implies that this conceptual space is altered altogether. This is what Boden calls *transformative* creativity. As she writes:

A given style of thinking, no less than a road system, can render certain thoughts impossible—which is to say unthinkable. The difference, as remarked above, is that thinking styles can be changed—sometimes, in a twinkling of an eye (Boden, 2004: 6).

To combine, explore, and transform are all essential ways in which creativity can happen, according to Boden. Indeed, Ackermann (2013) has seen these modes of practice among children growing up in the digital age. Ackermann suggests six areas of change in how children today apply old ideas to new situations.

3.2 Creative ways of being productive

In her paper 'Growing up in the Digital Age: Areas of Change', Ackermann (2013) identifies six areas of change that appear to inform how kids currently play and learn and, more generally, how they treat things, see themselves, dwell in places, and relate to others. In our research, we found these areas inspiring as a framework for understanding production and creativity, not only as something children do but also as the ways in which they do it. In the following discussion, we present Ackermann's six areas.

According to Ackermann, *sharism* is the first dimension characterizing today's children. They share even before they think of the finished state of their productions, not keeping things to themselves. *Fluid selves* is another aspect, where children explore different versions of themselves through multiple digital, virtual, and physical realms. *Crossing borders* is the third dimension. Ackermann points out that children move between worlds and urge others to cross both cultural and geographical borders. The fourth area of contemporary children's renewed approach to the world is the *literacy* dimension, in which children find new ways of expressing their experiences. They blend text, sounds, and images, and often borrow from those who inspire them. They invent new genres of writing by remixing, repurposing, and reconfiguring. As the fifth area, Ackermann mentions a *culture of gaming* or '*simuling*', which she uses to challenge the myth of gaming as escaping from reality. She states:

Games, like play, are more like a vacation. They offer a voie royale into the realm of "altered possibilities" which allow returning to "real life" better prepared, refreshed, stronger . . . Kids use fantasy not to get out of but into the world. They make up fictions, or dramatize everyday events, in order to de-dramatize the sometimes hard-to-handle reality. Intelligence itself, to Piaget, is about establishing a dialog between what is and what could be! (Ackermann, 2013: 125).

Simuling indicates a creation of an alternative world that is true and believable in its own right, in contrast to simulating, which implies pure reproduction. Ackermann's point is that children today use the digital tools that they are presented with, or already have, to try out playful exploration in ways rarely possible with pre-digital tools. These children expect immediate feedback and use these tools to 'simule' various ways of doing.

Tinkering, in Ackermann's (2013: 126) perception, is exploring and extending the understanding of technology or situations through using and 'making things "do things"' and this is her last characteristic way children today create—as *bricoleurs*, *makers*, *hackers*, and *hobbyists*. By trying things out, mixing things, and mending things together, they explore the possibilities of the world through what they create together. Through an iterative process of tweaking things, they empower their creations. The core point here is that they act before they think—or rather, they think while acting.

3.3 Playfulness in creative processes

Playfulness, in our understanding, is related to a way of being, in which goals and usefulness are not always at the centre of activities (Ejsing-Duun, 2011; Karoff, 2013). Ackermann (2014: 1) addresses being playful in creative processes as a necessary aspect since “[...]coming at things obliquely”—through suspension of disbelief (pretence), artful détournement (displacements), and playful exaggeration (looking at things from unusual angles)—allows [one] to break loose from the habitual’. To reach the stage in which one combines aspects normally not associated, explores the unknown and the known in fresh ways, or even transforms the area of interest, one needs to break habits and, sometimes, even perform what appear to be useless activities. Transgressing boundaries in playfulness is a driver for practices of change—and thus for creativity. These processes should not be tamed because, as Ackermann suggests:

[B]eyond our rational mind’s temptation to plan ahead and to stick to the plan (unless proven wrong or irrevocably cornered), and the blind maker’s insight-less errands, the playful wanderer enchants us through his own wondrous musings. S/he knows to look at things obliquely, cares to see what others don’t, and uses his/her intelligent hand—and connection to the materials—to bring forth the unexpected (Ackermann, 2014: 8).

This approach means that creators need to relate to the conceptual space within their interests without following a plan towards predefined objectives. However, as suggested by the above research, changing perspectives, experimentation and revisions are core activities that should be encouraged throughout the process, as is it important that learners gain feedback—and feed-forward—in order to reflect upon the productions (Levinson and Sørensen, 2015).

4 Analysis

Based on our study, we present the following important findings. First, an important part of creativity is exploring and trying things out in a playful—sometimes even foolish—way, without any specific goal. Second, ‘copying’ material and reworking premade material are important aspects of creative production that can lead to learning. Third, teachers need to engage in and appreciate the process of building upon existing material by providing and encouraging feedback and challenging students to ‘dig deep’.

4.1 Copycat or innovator?

Creative exploration is frequently based on a close imitation of something children already know extremely well, building upon existing knowledge, or something already produced, which is often mistaken for copying. When Simon made a game with the programming app Hopscotch, he downloaded an existing game and tweaked the codes and graphics—he hacked the game as a bricoleur and managed to navigate the game’s digital layers. This is what Ackermann (2013) coins as taking literacy beyond print, i.e., extending his ability to express himself to new media. He took the initiative to present his work to his teacher, sharing it without paying attention to whether it was finished. While hacking the game, he was simulating a creation of an alternative world; rather than creating a faithful reproduction of the original, he was adapting an existing game to his own purpose (Ackermann, 2013).

Being a student who is challenged by math, Simon would probably have been lost in the rather complex process of learning to program and invent a game from scratch, had the teacher insisted that this was required. However, Simon was engaged in changing variables and observing how values affect speed, positions, and geometrical shapes—all of which were matters relevant to the subject at hand, the conceptual space. Simon might not be an ‘innovator’, since he did not combine areas of knowledge or transform the conceptual space, but he worked creatively, exploring the field of interest and rehearsing and applying his knowledge of math. He explored how he could express himself through coding (literacies beyond print) as he reconfigured the game code that he had ‘borrowed’, and he hacked the game through an iterative process. He also sought the opportunity to explore the area even further as he shared it with the teacher, without thinking about what stage his work had reached.

Simon is not the only student who took a premade game as the point of departure for programming with Hopscotch. The data contain more examples of students who tweaked previously made games and applied pre-programmed blocks to their game. In this way, Hopscotch enables differentiation. However, this method was made more challenging by the teacher, who prompted the students to present their games to the class. In the presentations, she had the entire class explain the features of each game, then she had each student who

had designed a game describe how he or she had actually made it. In addition, the teacher challenged the class to find ways to improve their games and to explain their methods. Through this process, the teacher kept the focus on the conceptual space the students were exploring through their design processes—namely, algebra, variables, and algorithms—by facilitating discussions of their productions that related their work to the learning goals (Ejning-Duun, Hanghøj and Karoff, 2013). This was still relevant to the children as they wanted to learn this in order to improve their games.

4.2 Destructive or constructively disruptive?

In Oliver's class, imitation and copying seemed the main way to produce shapes, but Oliver did something else. While Oliver was trying the Geogebra program without a specific goal, he drew a funny mouse, came up with a story, and telling it to a friend, all within 10 minutes. By analysing the situation using the concepts of sharism and tinkering (Ackermann, 2013), an interesting observation is the ways 'messing around' with the digital tool facilitates creative and playful behaviour (Ito et al., 2009). This is an excerpt from the field notes:

Oliver opens Geogebra. His teacher has given him an assignment. He must draw a figure. Afterwards, he must give his figure assignment to a classmate. His classmate, then, must be able to make the same figure. Oliver makes a circle, he draws two lines across, some ears of two other circles, and, now, he has a mouse. He moves the lines within the mouse and talks with a mousy voice. Oliver laughs, he turns to Ida-Marie, the girl next to him. 'Look,' he says. He modifies his voice into a mouse voice, as he moves the two lines up and down, and it looks like a talking mouse. Ida-Marie is listening to the story, and Oliver says that his mouse is moving toward a dangerous mission. Ida-Marie laughs. Oliver continues to move the lines faster and faster, and the mouse eventually shouts very loudly (translated from Danish in field notes)

Oliver did not understand the program or digital tool extremely well; as mentioned previously, he preferred Paint. However, in this situation, he 'messed around' with the features, trying things out and drawing a mouse using circle shapes. He was not at all tuned into the assignment's goal, but, instead, his practices were explorative, resulting in a story told to his friend. In other words, they were playful as he was exaggerating the use of the tool (Ackermann, 2014). According to Ackermann's (2013) concept of 'tinkering', Oliver let the tool guide him, playing with features and possibilities as he explored the program. Neither the story nor the drawing was planned beforehand. Instead, Oliver was developing both while creating them, and, while he was doing this, he shared them. As Ackermann points out in her definition of sharism, sharing is the centre of accomplishments, and Ida-Marie became Oliver's audience, as her laughs made the lines move even faster.

Fooling around with digital tools is a well-established practice in classes for introducing something new to students' production processes. The data include several examples of students tinkering and fooling around while thinking. Teachers' ideas of learning practices are challenged by this type of creativity, primarily because the activity's goal is blurred. As Karoff (2013) mentions, this is quite distinctive to playfulness, and, using Ackermann's (2014) idea of looking at things obliquely, Oliver's practices seem to be driven by this process. He brought something unexpected to life, in connection to the material with which he was working. By introducing his classmate Ida-Marie to his unexpected exploration, he underlined the importance of sharing creative unexpectedness with others in order for the process to remain meaningful. However, in this specific case, the teacher was constantly keeping an eye on him, making sure that he did what he was supposed to do. She saw his fooling around as being destructive and not heading towards her planned goal.

4.3 Possibilities of iterations

By analysing the third situation using the concepts of 'old ideas influence' described by Tanggaard and Wegener (2015), exploration and combinatorial creativity described by Boden (2004), and tinkering described by Ackermann (2013), we want to show how an iterative process of producing games can help ensure that children's creativity is understood and nurtured by the teachers, not undermined.

In the beginning of the intervention, the children were introduced to different games as inspiration for them to make their own games; thus, previous knowledge and models were valued in the setup. Maya and Adam explained their invention (excerpt from the field notes):

We did a game called 'Thunder Hiding', Maya tells me. Okay, I say, can you tell me about the game. Yes, Maya says. One person is the 'catcher', and while that person is counting to ten

everybody has to hide. And then the 'catcher' has to find them, and after finding them 'catch' them. Adam continues telling me that you have to catch the person you have found otherwise the person is allowed to hide again.

This game 'Thunder Hiding' included game mechanics from both known hiding games and catching games. By combining these mechanics, the children have created a new type of game. Their knowledge of games, which in Tanggaard and Wegener's (2015) perspective are old ideas, becomes the material for new ways of playing. The material is blended in ways different from the games they were introduced to, and this blending can be seen as an example of Ackermann's (2013) concept of tinkering. While tinkering, the children practice playing the game in order to develop it. They explored different versions of the game to find the one that was most playable. In that sense, Ackermann's tinkering and Boden's exploration are closely related: the children use material to explore.

The game was not the only product of this learning process. The students also had to write an instruction manual explaining how the game is played. This gave the teacher the chance to focus on the students' competency with Danish through the composition of pictures and instructional text, as well as spelling and writing. The students also read aloud to each other, the teacher, and to the second author of this article during the process to ensure that they included all of the instructions for the game in the manual. In that sense, creating the manual was both meaningful to the teacher and the students.

In this case, the teacher supported the blending of old ideas, the exploration of ways in which the games could work, and the children's tinkering around to design a good game. The teacher was directly involved in trying the games out and was not only focused on evaluating the end product. She continuously invited the children to improve the game through trying it out again, and her evaluation became a feed-forward process involved in all versions of the games. In that sense, the teacher is initiating what Brinkmann and Tanggaard have described as possibility thinking, that is, constantly encouraging the students to formulate new positions towards the problem at hand, by noticing not how things are, but how they could be in the future through the question of 'does it work the way you want it to work?' (Brinkmann and Tanggaard, 2010). These two aspects of teacher involvement, involvement directly at possibility thinking and focus on all of the versions of the game, were absolutely crucial to the learning results of the process. These two aspects allow the teacher to understand the creative process of the children and support the development of the games in a productive way. In that sense, it is reasonable to say that introducing the iterative process to the learning situation makes it possible for the children to explore all aspects of creativity, and also lets the teacher understand and support the process of creativity in a productive way for the learning results. The students had the time to 'dig deep' through research, experimentation, and revision (Brinkmann and Tanggaard, 2009).

At the end of the intervention, the teacher facilitated a process of reflection upon the instruction manual to emulate the different models of the process. This allowed the students to find links between others' methods of accomplishing the task, as well as between the instruction manual and the actual game play. This final conversation also gave the students the chance to reflect upon their process in relation to those different perspectives (see Brinkmann and Tanggaard, 2009).

5 Discussion

In our study of several schools and teachers, a recurring conception was that children often are not very creative, which resonates with the exhaustive enthusiasm about novelty. As Tanggaard and Wegener point out: '[...]it is often emphasised that repeating or copying something is not creative, that speaking from memory is not creative, and furthermore, that routine activities such as walking home from work or drinking coffee are not creative' (Tanggaard and Wegener, 2015:4). In our study, many teachers saw creativity as a way of finding new and smart ways to solve specific problems related to educational objectives. They seemed to evaluate creativity as inventing something 'new' and previously unseen that made a difference. This evaluation and its related feedback favour the product over the process.

Some teachers expressed the worry that if they showed students an example of a premade product, the students would either simply make a variation of it, resulting in an uncreative process, or mindlessly reproduce the example and miss the potential for learning. As Ackermann writes:

A big problem among educators today is to come to grips with what they view as 'plagiarism': students' tendencies to pick-up and pass-on ready-made imports that have not been 'massaged' long enough, or mindfully engaged (Ackermann, 2013: 125).

In order to prevent aimless copying of other people's work or purposeless fooling around, the educators in this study made different suggestions and actual changes to innovate how they embrace and nurture productive processes. In planning interventions, some teachers considered not showing the children any examples to prompt more unique solutions. However, even in these situations, children used existing material and were inspired by each other. To prevent students from fooling around and keep students on track, another suggestion was to have them make a plan from the outset. Hence, not being goal-oriented was often understood by teachers as being unconstructive. This is in contrast to Ackermann (2014) that encourage process-oriented playfulness in creative process. These plans were seldom used throughout the processes, but served as a starting point. Yet another repeated idea was that good products require early analysis and planning before production. However, these suggestions do not support the way the children work as suggested by Ackermann (2013, 2014) and confirmed in our observations. In the third situation described above, things were somehow different. Children were shown existing games and the iterative process required that they 'dig deep' into the subject at hand while working on it. The different versions of the game produced during the process made the creative practices of the students clear to the teacher, and she followed along while suggesting future possibilities for the game. Also, when others followed the instructions in the game manual, their actions provided feedback to both the students and the teacher regarding how the manual worked and how the intended game was experienced. This approach resonates with both Ackermann's (2013) and Tanggaard and Wegener's (2015) approaches, as well as how we saw the children work. Lastly, it was clear that the students' and the teacher's understanding of the learning outcome corresponded (Levinson and Sørensen, 2015).

In two of the cases, the children were allowed to draw upon their own skills as game players in order to program and design games. Furthermore, the children designed games using their knowledge of old ideas about games. However, in all three situations they needed to explore an unfamiliar subject, such as math, in order to produce their game. In this context, it is important that the children acquire needed skills to engage in the production. As an example, the math teacher who planned the Hopscotch game programming intervention began with an initial tutorial that introduced the ideas behind programming and the syntax of the programming language. She then allowed her students to find their own paths. Making an introduction of the ideas related to the conceptual space and the skills needed to experiment and produce is particularly a good idea when students are unfamiliar with the tools or with the conceptual space they are working in, as was the case in the situations analysed in this paper. The math teacher's tutorial was designed to ensure that students were presented with the tool's features and that students related to the conceptual space in the same way that the tutorial's tasks related to it. The students could then fool around with the tools, trying out their features by copying and remixing content, as Simon did, to discover the tool's limitations and possibilities. Throughout the programming process, the math teacher made an effort to encourage the children to discuss their productions in terms of mathematics but also taught them to work with formulating problems related to producing the games that made them able to address these problems. This space for reflection on the production process is crucial for learners to be able to apply the acquired knowledge to other situations (Brinkmann and Tanggaard, 2009).

We argue that learning activities with digital tools that allow playfulness can support creativity, an essential twenty-first century skill. However, allowing students to fool around and embracing copying could be unhelpful or even directly destructive. This is a challenge within school systems that are increasingly goal-oriented. Teachers need to be alert to situations that emerge, to relate them to the conceptual space whenever possible, or, even better, to teach students to do so themselves and encourage possibility thinking (Brinkmann and Tanggaard, 2009). However, learning does not need to be only linked to a specific, set curriculum that is meant to represent the knowledge in an area. Students should be able to use and challenge the old ideas they encounter throughout the process (Brinkmann and Tanggaard, 2009). When Simon 'messed around' with the pre-programmed game, he was learning about games, about genres, about programming, about presenting, and so on. However, if teachers want their classes to learn about algebra as a group, then they should not develop objectives but rather formulate criteria that could guide the 'messaging around' and thus encourage exploration and combinations of materials. Furthermore, the math teacher noticed that some of the students became lost in the process when re-working games that were too complex for their level of expertise. The teacher must help keep the level of challenges and skills balanced in order for students to experience growth. It is important for the teacher to work closely with the students in the feedback process to ensure they stay within the conceptual space, i.e., the area that they are inquiring about.

The teacher's task is to maintain the students' focus on an examination of the conceptual space and to motivate the children to continuously explore the subject matter. The students gain a better understanding of the subject through the combination of knowledge fields or even transforming their understanding of it. They accomplish this by qualifying and refining their products. As Ackermann (2013: 121) points out, 'Digital natives are known for their launching of half-baked ideas and creations'. For these 'half-baked' ideas to be qualified further, the teacher's role is to provide time and space for continuous refinements. Thus, teachers cannot merely give students a task, send them into production mode with possible supervision, and evaluate the end products. On the contrary, working in an iterative process, in which teachers and students have time-outs during the class during which they assemble and re-evaluate students' productions in their current stage in relation to the conceptual space and together identify criteria for the ongoing production, has proven to be highly efficient. As Sørensen and Levinsen point out:

Ongoing evaluations with feedback and/or feed-forward can be used as short time-outs, where students and/or the teacher show and tell something that others can learn from, for example, when students have found out how to animate a graphic element (Sørensen and Levinsen, 2014: 7).

Throughout this ongoing evaluation and production process, teachers need to remain aware of what students are combining, exploring, and transforming and how this relates to the conceptual space. The challenge is to inquire about the students' intentions behind their 'messing around' and bring these into the conceptual space—or, if unrelated, dismiss them as such. Through this inquiry, teachers qualify the children's creativity in relation to the conceptual space, and, in connection to this space, make students refine their work, not only once, but again and again.

Over time, the children themselves need to learn to think in possibilities, and to use play as a gateway to creativity. This requires that they immerse themselves, experiment and revise their work. These skills are required in the 21st century.

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